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FR-A- 2 446 934
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JP-A-60 182 394

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Description

This invention relates to a turbo-molecular pump.

A known turbo-molecular pump has a plurality of stages of alternately arranged rotor blades and stator blades which are respectively carried by a rotor and a stator of the pump, the stages being arranged axially of the latter. In such a pump, however, if the pressure in the region of the suction port of the pump is more than 10^{-3} torr (0,133 Pa), the pump compression ratio is liable to be suddenly reduced and the load on the pump motor which drives the rotor is liable to suddenly be increased.

In JP-B-33446/72 there is therefore disclosed a turbo-molecular pump having a helical groove on either the rotor circumference or the stator circumference, the said helical groove being disposed on the discharge port side of said blades.

Also in FR-A-2,446,934 there is disclosed a turbo-molecular pump comprising a rotor; a stator; a plurality of stages of alternately arranged rotor blades and stator blades which are respectively carried by the rotor and stator; and a helical groove which is formed on the circumference of the rotor and which is disposed downstream of the said rotor blades and stator blades.

Further, in JP-A-182394/85 there is disclosed a turbo-molecular pump having helical grooves on both the rotor circumference and the stator circumference on the discharge port side of the said blades, the helical grooves being reversely threaded with respect to each other, i.e. of opposite hand.

The pumps disclosed in JP-B-33446/72 and FR-A-2,446,934, have the disadvantage that the pump compression ratio deteriorates so rapidly in the more than 1 torr (133.3 Pa) region that an adequate compression ratio is not attained. On the other hand, the pump disclosed in JP-B-18239/85 has the disadvantage that an adequate compression ratio is not obtained in the pressure region from ultra-high vacuum to 1 torr (133.3 Pa).

The object of the present invention is therefore to provide a turbo-molecular pump in which an adequate pump compression ratio can be obtained throughout a pressure region extending from ultra-high vacuum to a low vacuum region of about 10 torr (1333 Pa).

According, therefore, to the present invention there is provided a turbo-molecular pump comprising a rotor; a stator; a plurality of stages of alternately arranged rotor blades and stator blades which are respectively carried by the rotor and stator; and a first helical groove which is formed either on the circumference of the rotor or on the circumference of the stator and which is disposed downstream of the said rotor blades and stator blades; characterised in that second and third helical grooves are formed respectively on the circumferences of the rotor and stator downstream of the said rotor blades and stator blades, the second and third helical grooves being reversely threaded with respect to each other.

Preferably, the second and third helical grooves are dipsosed downstream of the first helical groove.

Either the stator or the rotor is preferably provided with a further stage of blades which are disposed between the first helical groove and the second and third helical grooves so as to facilitate gas flow to the second and third helical grooves.

Preferably, the second and third helical grooves are disposed opposite to each other.

The rotor is preferably mounted concentrically within the stator.

Preferably, the length of the rotor blades and stator blades of a downstream stage thereof is less than that of an upstream stage thereof.

The invention is illustrated, merely by way of example, in the accompanying drawings, in which:-

Figure 1 is a broken away cross-sectional elevation of part of a turbo-molecular pump according to the present invention;

Figure 2 is a graph illustrating the relationship between the pressure and the compression ratio of various turbo-molecular pumps; and

Figure 3 is a view similar to Figure 1 but showing another embodiment of the present invention.

In Figure 1 there is shown a first embodiment of a turbo-molecular pump according to the present invention, the pump comprising a rotor 16, a stator 22 within which the rotor 16 is concentrically mounted, and a plurality of axially successive stages (seven stages being shown in Figure 1) of alternately arranged rotor blades 10 and stator blades 18 which are respectively carried by the rotor 16 and stator 22. A first helical groove 12 is formed on the outer circumference of the rotor 16 on the downstream side of the blades 10, 18. Second and third helical grooves 14, 20 which are disposed downstream of the first helical groove 12, are formed on the outer and inner circumferences respectively of the rotor 16 and stator 22, the second and third helical grooves 14, 20 being reversely threaded with respect to each other, i.e. they are of opposite hand. The pump is provided at its upper end with a suction port 15 and is provided at its lower end with a discharge port (not shown).

The third helical groove 20 is provided opposite to the second helical groove 14. One further stage of blades 24 extend from the inner circumference of the stator 22. The blades 24 are disposed on the discharge port side of the first helical groove 12 and on the suction port side of the

second helical groove 14. The blades 24 are thus disposed between the first helical groove 12 and the second and third helical grooves 14, 20 so as to facilitate a flow of gas from the suction port 15 to the third helical groove 20, and to the second helical groove 14.

As set forth above, in the Figure 1 embodiment of the present invention, the first helical groove 12 is provided upon the outer circumference of the rotor 16 and is positioned on the downstream side of the blades 10, 18. Moreover, on the downstream side of the first helical groove 12, there are respectively provided on the outer circumference of the rotor and the inner circumference of the stator the helical grooves 14, 20 which are reversely threaded with respect to each other. Accordingly, the helical grooves 14, 20 can function effectively in a pressure region of more than 1 torr (133.3 Pa), while the helical groove 12 can function effectively in a pressure region of less than 1 torr (133.3 Pa).

In JP-B-33446/72, in the less than about 1 torr (133.3 Pa) pressure region, pump operation has been carried out in accordance with the characteristic 100 of the Figure 2 with the result that there has been a rapid deterioration in the pump compression ratio in this region as will be clear from the shape of the characteristic 100. On the other hand in JP-A-18239/85, in the more than about 1 torr (133.3 Pa) pressure region, pump operation has been carried out in accordance with the characteristic 102 so that an adequate compression ratio was not obtained in the pressure region from ultra-high vacuum to 1 torr (133.3 Pa).

In the embodiment of Figure 1, however, it is possible to obtain an adequate pump compression ratio from an ultra-high vacuum region to a low vacuum region so that the pump operating region is very much wider than in previous arrangements, as indicated by the line A shown in Figure 2.

Also, in the embodiment of Figure 1, an increase in the load of the rotor driving motor (not shown) can be avoided, because an adequate pump compression ratio can be obtained up to the low pressure vacuum region.

It is preferred to make the blade length of the blades 10, 18 shorten progressively toward the discharge port, as it is shown in the Figure 1 embodiment.

Another embodiment according to the present invention is shown in Figure 3. In the case of the Figure 3 embodiment, the turbo-molecular pump has a helical groove 12' which is provided on the inner circumference of the stator 22, and one stage of blades 24' which are provided around the outer circumference of the rotor 10.

As set forth above, the first helical groove 12 and the second and third helical grooves 14, 20 are so arranged in series that the groove 12 functions in the less than 1 torr (133.3 Pa) pressure region and the grooves 14, 20 function in the more than 1 torr (133.2 Pa) pressure region. Therefore, an adequate pump compression ratio can be obtained from the ultra-high vacuum region to the low vacuum region so as to widen the pump operation region substantially. Also an increase in the load of the motor which drives the rotor can be avoided because an adequate pump compression ratio is obtained up to the low vacuum region.

Claims

1. A turbo-molecular pump comprising a rotor (16); a stator (22); a plurality of stages of alternately arranged rotor blades (10) and stator blades (18) which are respectively carried by the rotor (16) and stator (22); and a first helical groove (12) which is formed either on the circumference of the rotor (16) or on the circumference of the stator (22) and which is disposed downstream of the said rotor blades (10) and the stator blades (18); characterised in that second and third helical grooves (14,20) are formed respectively on the circumferences of the rotor (16) and stator (22) downstream of the said rotor blades (10) and stator blades (18), the second and third helical grooves (14,20) being reversely threaded with respect to each other.

2. A turbo-molecular pump as claimed in claim 1 characterised in that the second and third helical grooves (14,20) are disposed downstream of the first helical groove (12).

3. A turbo-molecular pump as claimed in claim 2 characterised in that either the stator (22) or the rotor (16) is provided with a further stage of blades (24) which are disposed between the first helical groove (12) and the second and third helical grooves (14,20) so as to facilitate gas flow to the second and third helical grooves (14,20).

4. A turbo-molecular pump as claimed in any preceding claim characterised in that the second and third helical grooves (14,20) are disposed opposite to each other.

5. A turbo-molecular pump as claimed in any preceding claim characterised in that the rotor (16) is mounted concentrically within the stator (22).

6. A turbo-molecular pump as claimed in any

preceding claim characterised in that the length of the rotor blades (10) and stator blades (18) of a downstream stage thereof is less than that of an upstream stage thereof.

Revendications

1. Une pompe turbomoléculaire comprenant un rotor (16); un stator (22); un ensemble d'étages d'aubes de rotor (10) et d'aubes de stator (18) disposées en alternance, qui sont respectivement supportées par le rotor (16) et le stator (22); et une première rainure hélicoïdale (12) qui est formée soit sur la circonférence du rotor (16), soit sur la circonférence du stator (22), et qui est disposée en aval des aubes de rotor (10) et des aubes de stator (18); caractérisée en ce que des seconde et troisième rainures hélicoïdales (14, 20) sont respectivement formées sur les circonférences du rotor (16) et du stator (22), en aval des aubes de rotor (10) et des aubes de stator (18), les seconde et troisième rainures hélicoïdales (14, 20) s'enroulant dans des sens mutuellement inverses.

2. Une pompe turbomoléculaire selon la revendication 1, caractérisée en ce que les seconde et troisième rainures hélicoïdales (14, 20) sont disposées en aval de la première rainure hélicoïdale (12).

3. Une pompe turbomoléculaire selon la revendication 2, caractérisée en ce que le stator (22) ou le rotor (16) comporte un étage supplémentaire d'aubes (24) qui sont disposées entre la première rainure hélicoïdale (12) et les seconde et troisième rainures hélicoïdales (14, 20), de façon à faciliter l'écoulement du gaz vers les seconde et troisième rainures hélicoïdales (14, 20).

4. Une pompe turbomoléculaire selon l'une quelconque des revendications précédentes, caractérisée en ce que les seconde et troisième rainures hélicoïdales (14, 20) sont disposées face à face.

5. Une pompe turbomoléculaire selon l'une quelconque des revendications précédentes, caractérisée en ce que le rotor (16) est monté en position concentrique à l'intérieur du stator (22).

6. Une pompe turbomoléculaire selon l'une quelconque des revendications précédentes, caractérisée en ce que la longueur des aubes de rotor (10) et des aubes de stator (18) d'un étage aval est inférieure à celle d'un étage amont de ces aubes.

Ansprüche

1. Turbomolekularpumpe mit einem Rotor (16), einem Stator (22), einer vielzahl von Stufen abwechselnd angeordneter Rotorblätter (10) und Statorblätter (18), welche vom Rotor (16) bzw. vom Stator (22) getragen sind, und mit einer ersten schraubenförmigen Nut (12), welche entweder auf dem Umfang des Rotors (16) oder dem Umfang des Stators (22) ausgebildet ist und in Strömungsrichtung vor den Rotorblättern (10) und den Statorblättern (18) angeordnet ist, **dadurch gekennzeichnet**, daß eine zweite und eine dritte schraubenförmige Nut (14, 20) auf dem Umfang des Rotors (16) bzw. des Stators (22) in Strömungsrichtung vor den Rotorblättern (10) und den Statorblättern (18) ausgebildet sind, die in Bezug aufeinander gegensinnig schraubenförmig angeordnet sind.

2. Turbomolekularpumpe nach Anspruch 1, **dadurch gekennzeichnet**, daß die zweite und dritte schraubenförmige Nut (14, 20) in Strömungsrichtung vor der ersten schraubenförmigen Nut (12) angeordnet sind.

3. Turbomolekularpumpe nach Anspruch 2, **dadurch gekennzeichnet**, daß entweder der Stator (22) oder der Rotor (16) mit einer weiteren Stufe von Blättern (24) versehen ist, welche zwischen der ersten schraubenförmigen Nut (12) und der zweiten und dritten schraubenförmigen Nut (14, 20) so angeordnet ist, daß der Gasfluß zur zweiten und dritten schraubenförmigen Nut (14, 20) erleichtert wird.

4. Turbomolekularpumpe nach den vorhergehenden Ansprüchen, **dadurch gekennzeichnet**, daß die zweite und dritte schraubenförmige Nut (14, 20) sich gegenüberliegend angeordnet sind.

5. Turbomolekularpumpe nach den vorhergehenden Ansprüchen; **dadurch gekennzeichnet**, daß der Rotor (16) konzentrisch im Stator (22) montiert ist.

6. Turbomolekularpumpe nach den vorhergehenden Ansprüchen, **dadurch gekennzeichnet**, daß die Länge der Rotorblätter (10) und der Statorblätter (18) einer in Strömungsrichtung vorderen Stufe kleiner als die einer in Strö-

mungsrichtung hinteren Stufe ist.

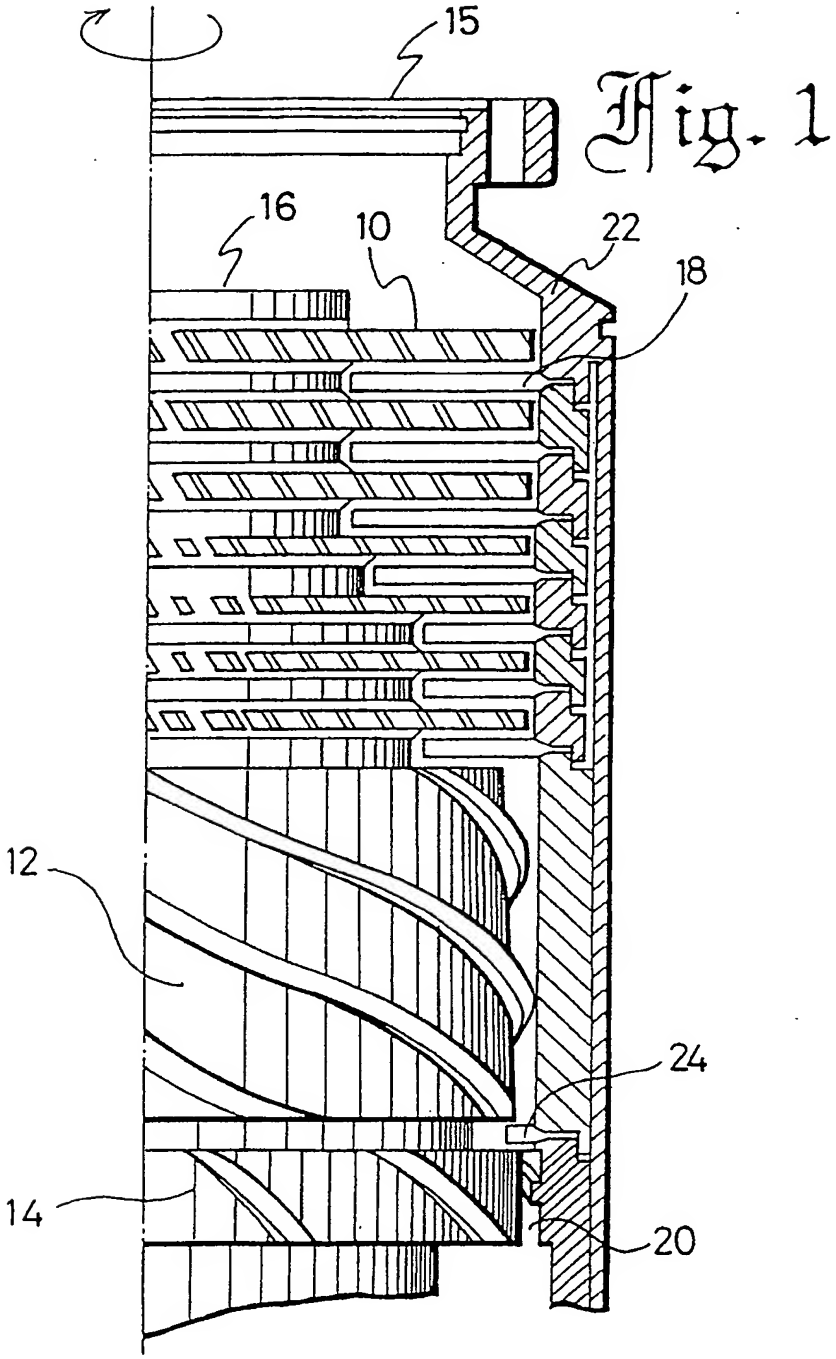

Fig. 1

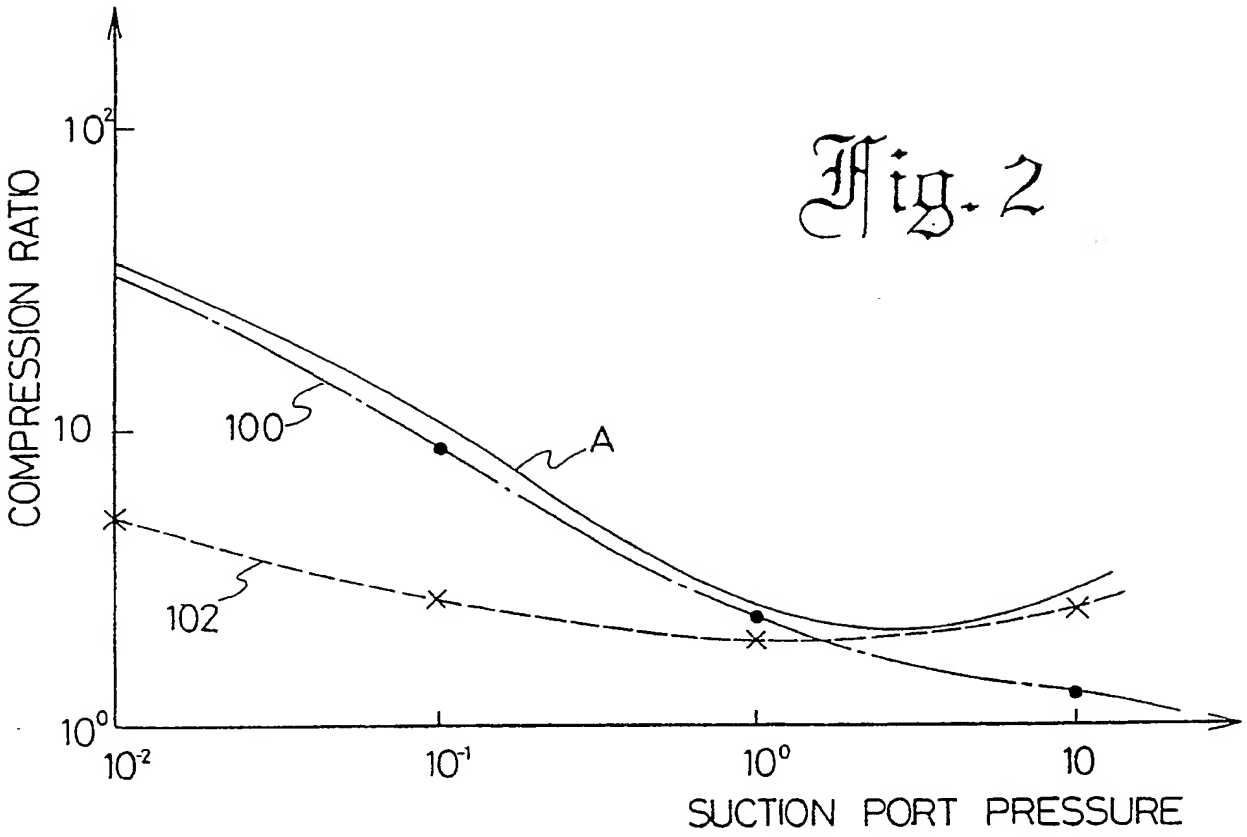
COMPRESSION RATIO
10^2
10
10^0
100
A
102
10^{-2}
10^{-1}
10^0
10
SUCTION PORT PRESSURE

Fig. 2

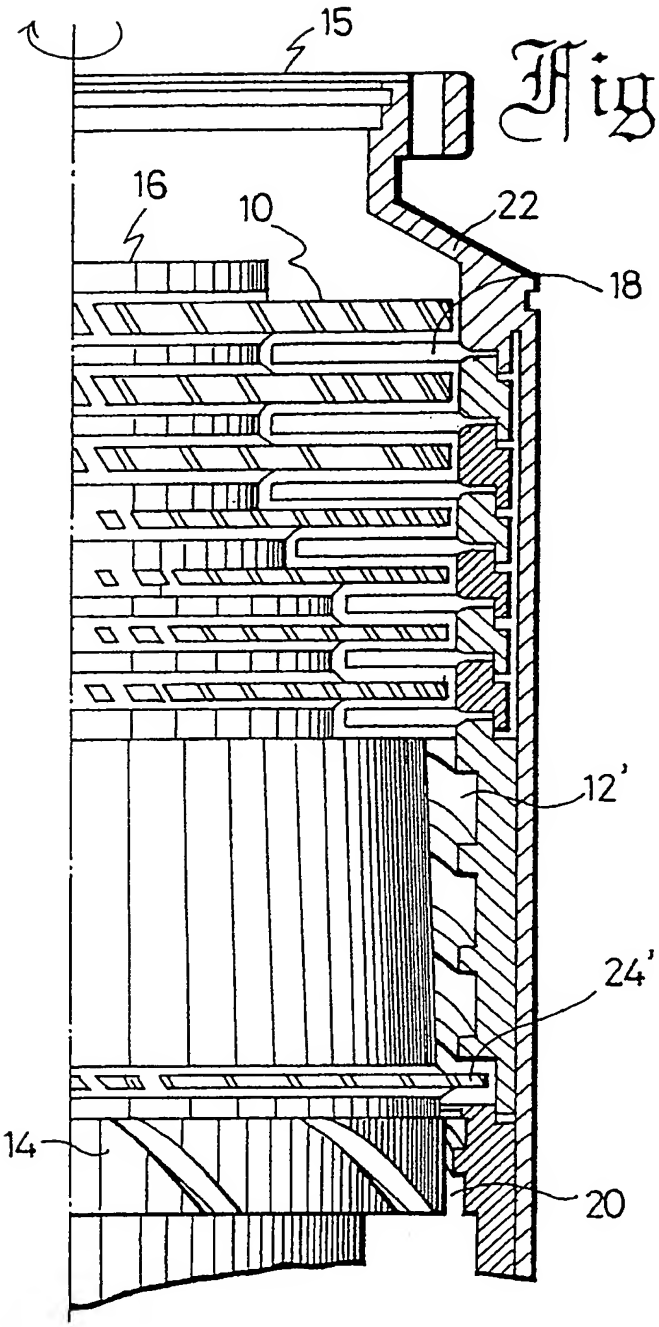

Fig. 3